

Spondylolisthesis in an Etruscan Woman from Spina (Ferrara, Italy): an Iron Age Case Report

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ABSTRACT

Spondylolisthesis consists of the slippage of a vertebra in relation to the one beneath. It is caused by separation of the neural arch from the vertebral body (spondylolysis), and predominantly occurs at the isthmus (pars interarticularis). Originally thought to be a congenital anomaly, its strict correlation with certain activities that seem to exert stress on lower spine was later demonstrated. This paper describes a case of progression of spondylolysis to spondylolisthesis found on an adult female skeleton from the Etruscan necropolis of Spina (Ferrara, Italy). The case in question was identified among 209 skeletons exhumed at Spina. As spondylolisthesis is strictly connected with activities that exert stress on lower spine, the evidence suggests that this woman was engaged in stressful physical activity, perhaps related to the specific trade function of the site.

Key words: spondylolysis, isthmic spondylolisthesis, adult spondylolisthesis, stressful activity

Introduction

According to the International Society for the Study of the Lumbar Spine classification of spondylolisthesis¹, five types exist: dysplastic, isthmic, degenerative, traumatic, and pathological. Isthmic spondylolisthesis, in particular, is due to separation of the neural arch from the vertebral body at the pedicle, which is the tubular osseous structure connecting the vertebral arch to vertebral body², and the subsequent anterior displacement of the latter relative to the vertebra below. Spondylolisthesis arises from complete bilateral fracture at the spondylolytic *pars interarticularis*^{3–6}; spondylolysis itself can be unilateral or bilateral, symmetrical or asymmetrical. The etiology of spondylolysis is controversial⁶. Traditionally considered a congenital anomaly due to developmental ossification failure of the laminae⁷, it was later demonstrated that the incidence of this condition increases with age; it also occurs with higher frequency in individuals engaged in certain activities which seem to exert stress on the lower spine^{5–8}. The two causes of spondylolysis, congenital and traumatic, are presumably not mutually exclusive: a congenital weakness of the vertebral isthmus may be the genetic cause of the breakage which occurs when the lumbar spine is then submitted to normal or low levels of repeated stress^{5,8,9}. Epidemiological studies have demonstrated that isthmic spondylolysis

predominantly manifests itself during adolescence or early adulthood^{6,10,11}.

The aim of this study was to present a case of symmetrical bilateral spondylolysis found on a L5 vertebra from an ancient Etruscan skeleton exhumed from the necropolis at Spina (6th–3rd century BC); some paleopathological evidence found in the specimen also suggest a progression of spondylolysis to isthmic spondylolisthesis.

Materials and Methods

The osseous remains in question, denoted 1363 VT (grave no.1363 from the Valle Trebba locality), belongs to a sample of 209 skeletons taken from the Etruscan necropolis at Spina (Ferrara, Italy). The archaeological site situated here was one of the most important on the Po River plain, and dates back to the Etruscan era (Iron Age). Between the 6th and 3rd centuries BC, Spina became a flourishing port on the Upper Adriatic, through which the Etruscans habitually traded with the Greeks¹². As the necropolis of Spina was excavated under unfavorable conditions^{12,13}, the sample is unfortunately poorly preserved: most skeletons are fragmented, and some individuals are represented by only a few bones. Therefore

only 152 vertebrae, belonging to 31 different individuals, are present: 69 cervical, 54 thoracic, and 29 lumbar. The cervical vertebrae came from a total of 15 skeletons (7 males and 8 females); the thoracic from 11 (5 males, 5 females and one indeterminate); and the lumbar vertebrae from a total of 12 individuals (5 males, 6 females and one indeterminate). Among the 29 lumbar vertebrae analyzed, 6 were identified as L1, 6 as L2, 5 as L3, 5 as L4, and 7 as L5. Only seven individuals (2 M and 5 F) possessed the L5 vertebra. The osseous material was aged and sexed according to standard anthropological techniques^{14–17}, and examined from a paleopathological perspective. Only skeleton 1363 showed symmetrical bilateral spondylolysis of the 5th lumbar vertebra, with pathological evidence suggesting a progression to spondylolisthesis^{6,8}.

Results

Skeleton 1363 VT was incomplete and poorly preserved, and only the following fragments were present: pieces of skull and mandible, the left mandibular 3rd molar, the left clavicle, the L5 vertebra (the only one preserved), some pieces of the pelvis, and the distal epiphysis of the right femur. Anthropological analysis indicated that these bones belonged to an adult woman aged 40–44 years. Macroscopic analysis evinced a complete bilateral separation between the arch and body at the isthmus, or *pars interarticularis* (Figure 1), of the L5 vertebra. The cleft was found to be bilateral and symmetrical, and completely separates the vertebral body and pedicles, transverse processes and upper articular processes (still present) from the laminae, spinous process and zygoapophyses (lacking). Both apophyses show reabsorption and remodeling at the point of fracture (Figures 2–4) with little impingement of the neural canal by irregular new bone; the left side shows slightly more remodeling than the right, thereby suggesting that the cleavage occurred initially on the former (Merbs, 2002). Both articular processes present marked remodeling, which indicates that



Fig. 1. The 5th lumbar vertebra of skeleton 1363 VT, showing bilateral symmetrical spondylolysis.



Fig. 2. Detail of fractures, showing remodeling.



Fig. 3. Detail of left *pars interarticularis* with remodeled fracture.

the separation took place a long time *ante mortem*. The upper end-plate of the L5 vertebral body exhibits no evidence of degeneration, rather vertebral body compression at the medial portion of the lower end-plate; the evident cupping of the end-plate and accompanying pitting and sclerosis suggest involvement of the inter-vertebral disc. This evidence, together with the presence of an osteophyte (Figure 5) on the left side of the lower *plateau* of the vertebral body, is indicative of the presence of olisthesis of the L5, which had slipped forward on the sacrum (antero-listhesis)^{8,18,19}.

Discussion and Conclusion

Spondylolisthesis is not a rare consequence of bilateral spondylolysis: if the vertebral body becomes separated from the arch (a condition typical of symmetrical bilateral spondylolysis) it becomes free to slip. Anterior slippage is particularly common in the case of spondylolysis involving the lumbo-sacral region, where the vertebral bodies are ventrally oriented downwards due to curvature of the lumbar spine and gravity. Spondylolysis is generally found in between 3% and 10% of the current adult population¹⁷. The frequency of this condition varies



Fig. 4. Detail of right *pars interarticularis* with remodeled fracture.



Fig. 5. Detail of osteophyte on left edge of lower end-plate sclerosis and surface re-absorption due to inter-vertebral disc degeneration.

between races, peaking at 35% in Alaskan Eskimos⁵, suggesting their particular predisposition, probably related to subsistence activities. As mentioned above, the etiology of spondylolysis is genetic predisposition succeeded by repeated stress to the *pars interarticularis*. In particular, it seems that spondylolysis is the result of mechanical forces, especially hyperextension, hyperflexion and torque of the lumbar spine, acting on the vertebral isthmus¹⁹: »from a biomechanical point of view, the inferior processes of a vertebra and their related facets act as a hammer impacting the *pars interarticularis* region of the contiguous inferior vertebra, which acts as an anvil. With a recurrent hammering force or an acute trauma that exceeds the force sustainable in this articular area, stress fracture can occur²¹. Indeed, spondylolysis is found frequently in athletes and workers who carry out intense physical activities, such as lifting heavy objects^{10,11,21–23}. In previously documented archaeological skeletal remains,

a high incidence of bilateral and complete spondylolysis has been found in the lumbar spines of adult males in Chamorro graves (Hyatt site, Tumon Bay, Guam Isle) from the Latte Period (1200–1521 AD)²⁰; this disease, observed with particular frequency in adult males, is deemed to be the direct consequence of daily physical and occupational activities, namely fishing, harpooning and pulling or lifting the heavy stones used as house pillars. Moreover a high frequency of spondylolysis was also found in a sample from a late Chinchorro fishing population in Arica, Chile (about 2000 BC)³, in whom bilateral separation of the neural arch was reported in 18% of males (affected females were not detected). Bio-archaeological studies have demonstrated that the Chinchorro people practiced a strict division of labour²¹, thus only the male population was affected by spinal trauma, probably caused by their maritime subsistence, i.e. hunting sea mammals and collecting shellfish from the slippery rocks on the rocky coastal area where they lived.

The pattern of spondylolysis on the L5 of the female skeleton 1363 VT, as seen by macroscopic observation of the isthmus, or *pars interarticularis*, is consistent with a diagnosis of isthmic spondylolisthesis, even though dysplastic spondylolisthesis cannot be completely excluded owing to the poverty of the skeletal sample. However, neither can the possibility that this 40–44 year-old woman suffered from lower back pain caused by a developmental type of spondylolisthesis be dismissed¹⁰. Indeed, the presence of complete remodeling at the point of fracture and little impingement of the neural canal by new bone suggests that the cleavage in question took place after puberty (probably when she was 20 years old), which accords with the specific age of incidence of cleavage at the *pars interarticularis* reported by Earl¹⁰ and Mays²⁵. The breakage pattern documented herein reflects the changing biomechanical properties of the human lumbar spine during the transition between the pubertal stage and full adulthood, when the neural arch has not yet reached the strength of the latter, but is less elastic than during childhood or adolescence; the capsular ligaments of the apophyseal joint are stronger and bone is less stiff in younger than in older adults, thus the former group has a greater propensity towards bending about the *pars interarticularis*, and hence a tendency toward fatigue failure under repetitive loading. Moreover, despite the sex of the affected specimen, the evidence gathered leads us to speculate that she engaged in activities that exerted high levels of static and dynamic stress on the lumbar region, above the threshold tolerable by the bone in question, which entailed repetitive cyclical extension and torsion of the spine, such as lifting and carrying heavy objects^{1,10,20}. However, another possible cause of stress to the lumbar region could be pregnancy and the habit of carrying children in the arms⁸.

In conclusion, this investigation reveals spondylolysis and spondylolisthesis in a female Iron Age specimen from Northern Italy. It is feasible that this pathological pattern was not infrequent in past populations, particularly among Etruscans involved in the loading of goods

and related activities that took place in trade centers such as Spina. Nevertheless, as the level of skeletal preservation can affect spondylolysis and spondylolisthesis detection in ancient populations⁴, the high degree of fragmentation of the skeletal artifacts prevents us from evaluating the incidence of these pathologies in this population as a whole.

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SPONDILOLISTEZA U ETRUŠČANSKE ŽENE IZ SPINE (FERRARA, ITALIJA): PRIKAZ SLUČAJA IZ ŽELJEZNOG DOBA

SAŽETAK

Spondilolisteza se sastoji od proklizavanja kralješka u odnosu na kralježak ispod. Događa se zbog odvajanja neuronskog luka iz tijela kralješka (spondilolize), i uglavnom se pojavljuje kod prevlake (PARS interarticularis). Izvorno se mislio da je prirodna anomalija, no kasnije se pokazala stroga povezanost s određenim aktivnostima koje vrše pritisak na donji dio kralježnice. Ovaj članak opisuje slučaj progresije spondilolize na spondilolistezu, otkrivenu na kosturu odrasle žene iz etruščanske nekropole Spina (Ferrara, Italija). U ovom konkretnom slučaju riječ je o identificiranom kosturu među 209 kostura ekshumiranih u Spini. Spondilolisteza strogo je povezana s aktivnostima koje se događaju zbog stresa na donji dio kralježnice, a dokazi upućuju na to da je ta žena bila angažirana stresnom fizičkom aktivnošću, koja se vjerojatno odnosi na određenu funkciju trgovine na mjestu ovog nalazišta.